period, or about 26 days earlier; that is, about 1872, Oct. 21. Prof. Peters' results, therefore, agree remarkably with mine, both as to the magnitude of the variation and the time of its maximum effect.

On the other hand, Dr. Nyrén, from a thorough discussion of three series of Pulkowa observations made by Peters, by Gyldén, and by himself, has arrived at discordant results, and concludes that there is no constancy of magnitude or phase in the variation of apparent latitude. Dr. Nyrén's investigation is contained in his paper entitled *Die Polhöhe von Pulkowa.* There appears, therefore, to be this difficulty about the question—that if a short series of observations is used we cannot be sure that we have satisfactorily got rid of accidental errors, or of errors (possibly) depending on the refraction having periods of twelve months, or of six months; and if we discuss a sufficiently long series of observations to eliminate these errors, we make what may be an illegitimate assumption—viz., that the variation remains constant.

The co-latitude of Greenwich deduced from the ten-years' observation of *Polaris* is

$$38^\circ\ 31'\ 21''\!\cdot\!811 \pm 0''\!\cdot\!011.$$

Blackheath,
1880, *May* 10.

On a Photograph of Jupiter's Spectrum showing Evidence of Intrinsic Light from that Planet. By Henry Draper, M.D.

There has been for some years a discussion as to whether the planet *Jupiter* shone to any perceptible extent by his own intrinsic light, or whether the illumination was altogether derived from the Sun. Some facts seem to point to the conclusion that it is not improbable that *Jupiter* is still hot enough to give out light, though perhaps only in a periodic or eruptive manner.

It is obvious that spectroscopic investigation may be usefully employed in the examination of this question and I have incidentally, in the progress of an allied inquiry,* made a photograph which has sufficient interest to be submitted to the inspection of the Astronomical Society.

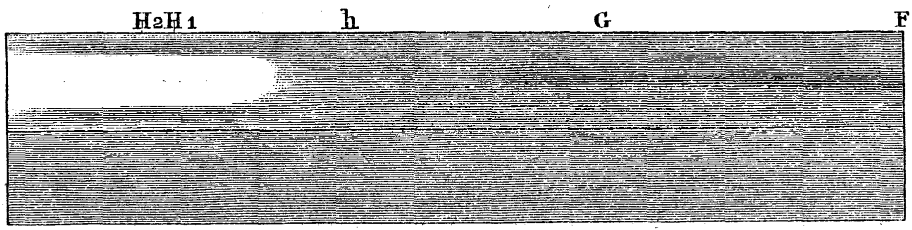
If the light of *Jupiter* is in large part the result of his own incandescence it is certain that the spectrum must differ from that of the Sun, unless the improbable hypothesis is advanced that the same elements, in the same proportions and under the same physical conditions, are present in both bodies. Most of

* See paper *On Photographing the Spectra of the Stars and Planets*, read before the American National Academy of Sciences, Oct. 28, 1879, and published in *Nature*, Nov. 27, 1879, and in the *American Journal of Science*, Dec. 1879.

the photographs I have made of the spectrum of *Jupiter* answer this question decidedly, and from their close resemblance to the spectrum of the Sun indicate that under the average circumstances of observation almost all the light coming to the Earth from *Jupiter* must be merely reflected light originating in the Sun. For this reason I have used the spectrum of *Jupiter* as a reference spectrum on many of my stellar spectrum photographs.

But on one occasion, viz. on September 27, 1879, a spectrum of *Jupiter* with a comparison spectrum of the Moon was obtained which shows a different state of things. Fortunately, owing to the assiduous assistance of my wife, I have a good record of the circumstances under which this photograph was taken, and this will make it possible to connect the aspect of *Jupiter* at the time with the spectrum photograph, though I did not examine *Jupiter* with any care through the telescope that night, and indeed did not have my attention attracted to this photograph till some time afterwards.

I send herewith to the Astronomical Society for examination the original negative, which is just as it was produced, except that it has been cemented with Canada balsam to another piece of glass for protection. Attached to the photograph is an explanatory diagram (*see* figure) intended to point out the peculiarities which are of interest. It will be noticed at once that the main dif-



ference is not due to a change in the number or arrangement of the Fraunhofer lines, but rather to a variation in the strength of the background. In the case of the Moon the background is uniform across the width of the spectrum in any region, but in the case of *Jupiter* the background is fainter in the middle of the width of the spectrum in the region above the line *h*, and stronger in the middle in the region below *h*, especially toward F. The observer must not be confused by the dark portion where the two spectra overlap along the middle of the combined photograph.

In order to interpret this photograph it must be understood that the spectrum of *Jupiter* is produced from an image of the planet thrown upon the slit of the spectroscope by a telescope of 183 inches focal length, the slit being placed approximately in the direction of a line joining the poles of the planet. The spectroscope did not, therefore, integrate the light of the whole disk, but analysed a band at right angles to the equator and

extending across the disk. If either absorption or production of light was taking place on that portion of *Jupiter's* surface, there might be a modification in the intensity of the general background of the photograph spectrum.

A casual inspection will satisfy anyone that such modifications in the intensity of the background are readily perceptible in the original negative. They seem to me to point out two things that are occurring: first, an absorption of solar light in the equatorial regions of the planet; and, second, a production of intrinsic light at the same place. We can reconcile these apparently opposing statements by the hypothesis that the temperature of the incandescent substances producing light at the equatorial regions of *Jupiter* did not suffice for the emission of the more refrangible rays, and that there were present materials which can absorb those rays from the sunlight falling on the planet.

If the spectrum photograph exhibited only the absorption phenomenon above *h* the interest attached to it would not be great, because a physicist will readily admit from theoretical considerations that such might be the case owing to the coloured belts of the planet. But the strengthening of the spectrum between *h* and F in the portions answering to the vicinity of the equatorial regions of *Jupiter* bears so directly on the problem of the physical condition of the planet as to incandescence that its importance cannot be overrated.

The circumstances under which this photograph was taken were as follows:—Longitude of Observatory, $4^h\ 55^m\ 29^s{\cdot}7$ W. of Greenwich. Night not very steady. *Jupiter* and the Moon differed but little in altitude. *Jupiter's* spectrum was exposed to the photographic plate for 50 minutes, the Moon was exposed for 10 minutes. *Jupiter* was near the meridian. The photograph of *Jupiter's* spectrum was taken between $9^h\ 55^m$ and $10^h\ 45^m$ New York mean time, September 27, 1879.

I have suspected that perhaps there may have been an influence produced by the great coloured patch on Jupiter which has made itself felt in this photograph. It may be that eruptions of heated gases and vapours of various composition, colour, and intensity of incandescence are taking place on the great planet; and a spot which would not be especially conspicuous from its tint to the eye might readily modify the spectrum in the manner spoken of above.